New York State
Department of Environmental Conservation

Division of Water

Canacadea Creek

Biological Assessment

1998 Survey

GEORGE E. PATAKI, *Governor*

JOHN P. CAHILL, *Commissioner*

BIOLOGICAL STREAM ASSESSMENT

Canacadea Creek
Allegany and Steuben Counties

Survey date: August 13, 1998
Report date: May 28, 1999

Robert W. Bode
Margaret A. Novak
Lawrence E. Abele

Stream Biomonitoring Unit
Bureau of Watershed Assessment and Research
Division of Water
NYS Department of Environmental Conservation
Albany, New York

CONTENTS

Background........ 1

Results and Conclusions........ 1

Discussion........ 2

Literature cited........ 3

Overview of field data........ 3

Figure 1. Biological Assessment Profile........ 4

Table 1. Impact Source Determination........ 5

Table 2. Station locations........ 6

Figure 2. Site overview map........ 7

Figure 3. Site location maps........ 8

Table 3. Macroinvertebrate species collected........ 11

Invertebrate collection data 13

Laboratory data summary........ 19

Field data summary........ 21

Appendix I. Biological methods for kick sampling........ 23

Appendix II. Macroinvertebrate community parameters........ 24

Appendix III. Levels of water quality impact in streams........ 25

Appendix IV. Biological Assessment Profile derivation........ 26

Appendix V. Water quality assessment criteria........ 27

Appendix VI. Traveling kick sample illustration........ 28

Appendix VII. Macroinvertebrate illustrations........ 29

Appendix VIII. Rationale for biological monitoring........ 31

Appendix IX. Glossary........ 32

Appendix X. Characteristics of headwater stream sites........ 33

Appendix XI. Impact Source Determination........ 34

Stream: Canacadea Creek, Allegany and Steuben Counties, New York

Reach: above Alfred to Hornell, New York

Background:

The Stream Biomonitoring Unit conducted biological sampling on Canacadea Creek on August 13, 1998. The purpose of the sampling was to assess general water quality and compare results to previous surveys. Traveling kick samples were taken in riffle areas at 6 sites, using methods described in the Quality Assurance document (Bode et al., 1996) and summarized in Appendix I. The contents of each sample were field-inspected to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of a 100-specimen subsample. Water quality assessments were based on resident macroinvertebrates (aquatic insects, worms, mollusks, crustaceans). Community parameters used in the determination of water quality included species richness, biotic index, EPT value, and percent model affinity (see Appendices II and III). Table 2 provides a listing of sampling sites, and Table 3 provides a listing of all macroinvertebrate species collected in the present survey. This is followed by site collection synopses, which include the raw invertebrate data and descriptions of each site.

Results and Conclusions:

1. Water quality in Canacadea Creek is considered slightly impacted for its entire length. The composition of the invertebrate fauna indicates impacts primarily from siltation.

2. The Alfred Wastewater Treatment Facility discharge had slight toxic effects on the invertebrate fauna. These effects persisted for approximately 5 stream miles.

3. The site in Hornell indicated organic waste influences, and should be investigated for discharges upstream.

4. Siltation and sediment load remain substantial problems in Canacadea Creek.

Discussion:

The purpose of this biological sampling of Canacadea Creek was to assess general water quality, and compare with results of previous samplings. Previous macroinvertebrate surveys of locations on Canacadea Creek include Stream Biomonitoring Unit sampling above Hornell (Station 4) in 1991 and 1992 , as part of the Rotating Intensive Basins Studies (Bode et al., 1994). Results of these samplings both indicated moderately impacted water quality, and the impact appeared to be toxic. Tissue analysis of crayfish from this site found mercury and aluminum exceeding provisional levels of concern. An earlier DEC macroinvertebrate survey of Canacadea Creek was conducted in 1973 by Neuderfer et al. (1974), as part of a Canisteo River study. In that survey, 5 sites were sampled from Alfred to Hornell. Water quality was assessed as good upstream of the WWTF, moderately impacted downstream of the Alfred WWTF discharge, good downstream of the Almond Reservoir, and poor in Hornell, possibly due to toxic discharges.

Station-by-station results of the present study found the most upstream site at Alfred to exhibit headwater effects (see Appendix X). Species richness and EPT richness were low, while the fauna was dominated mostly by intolerant species. The predominately gravel substrate at this site also was considered to have a limiting effect on the fauna.

Downstream of the discharge of the Alfred (Village) Sewage Treatment Plant (Station 1), a faunal change occurred. Although the substrate was more favorable than at the upstream site, the clean-water indicator midge Polypedilum aviceps decreased, while tolerant species such as Nais variabilis and Cricotopus increased. The biotic index reflected impacts from organic wastes, and Impact Source Determination showed toxic impacts (Table 1). Siltation was also a factor at this site. Although species richness and EPT richness increased compared to Station A due to improved habitat, the fauna is interpreted as reflecting slight impact from the sewage treatment plant discharge.

These effects persisted at Station 2, 2.8 miles downstream of the sewage treatment plant discharge. All indices declined compared to Station 1, and Impact Source Determination continued to show toxic effects. At Station 3 in Almond, 5.1 miles below the discharge, the impact appeared to have diminished. Three of the four indices improved, and no toxic effect was indicated. Water quality remained slightly impacted by siltation.

Between Almond and Hornell, Canacadea Creek is impounded to form Almond Lake Reservoir. This impoundment undoubtedly affects the invertebrate fauna at downstream sites, although siltation is the primary impact at Station 4. Conditions at this site appeared somewhat improved from the 1991-1992 samplings. The fauna of Station 5 in Hornell indicated organic waste impacts, although no point sources are known in this area. This site also had poor water quality in the 1973 survey, and should be investigated for discharges upstream.

Siltation and sediment load remain substantial problems in Canacadea Creek. Siltation was shown to be a major factor influencing the fauna at every site (Table 1). Gravel mining operations upstream have been cited as possible sources of this problem (see Priority Water List, NYS DEC 1996).

Literature cited

Bode, R.W., M.A. Novak, and L.E. Abele. 1996. Quality assurance work plan for biological stream monitoring in New York State. New York State Department of Environmental Conservation, Albany, NY. NYS DEC Technical Report, 89 pages.

Bode, R.W., M.A. Novak, and L.E. Abele. 1994. Rotating Intensive Basin Studies. Appendix B. Macroinvertebrate data. New York State Department of Environmental Conservation, Albany, NY. NYS DEC Technical Report, 171 pages.

Neuderfer, G.N., M.J. Tracy, J. Baskins, and G. Battinelli. 1974. A macroinvertebrate study of the Canisteo River. New York State Department of Environmental Conservation, Avon Pollution Investigations, Avon, New York. 25 pages + 29 appends.

New York State Department of Environmental Conservation. 1996. The 1996 priority waterbodies list for the Chemung River basin. New York State Department of Environmental Conservation Technical Memorandum, 41 pages.

Overview of field data:

On the date of sampling, August 13, 1998, the sites sampled on Canacadea Creek were 2-30 meters wide, 0.05-0.2 meters deep in riffles, and had current speeds of 40-80 cm/sec in riffles. Dissolved oxygen was 8.6-10.3 mg/l, specific conductance was 240-572 µmhos, pH was 8.2-8.7, and the temperature was 12.4-23.3 °C (54-74 °F). Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, Canacadea Creek, 1998. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. See Appendix IV for more complete explanation.

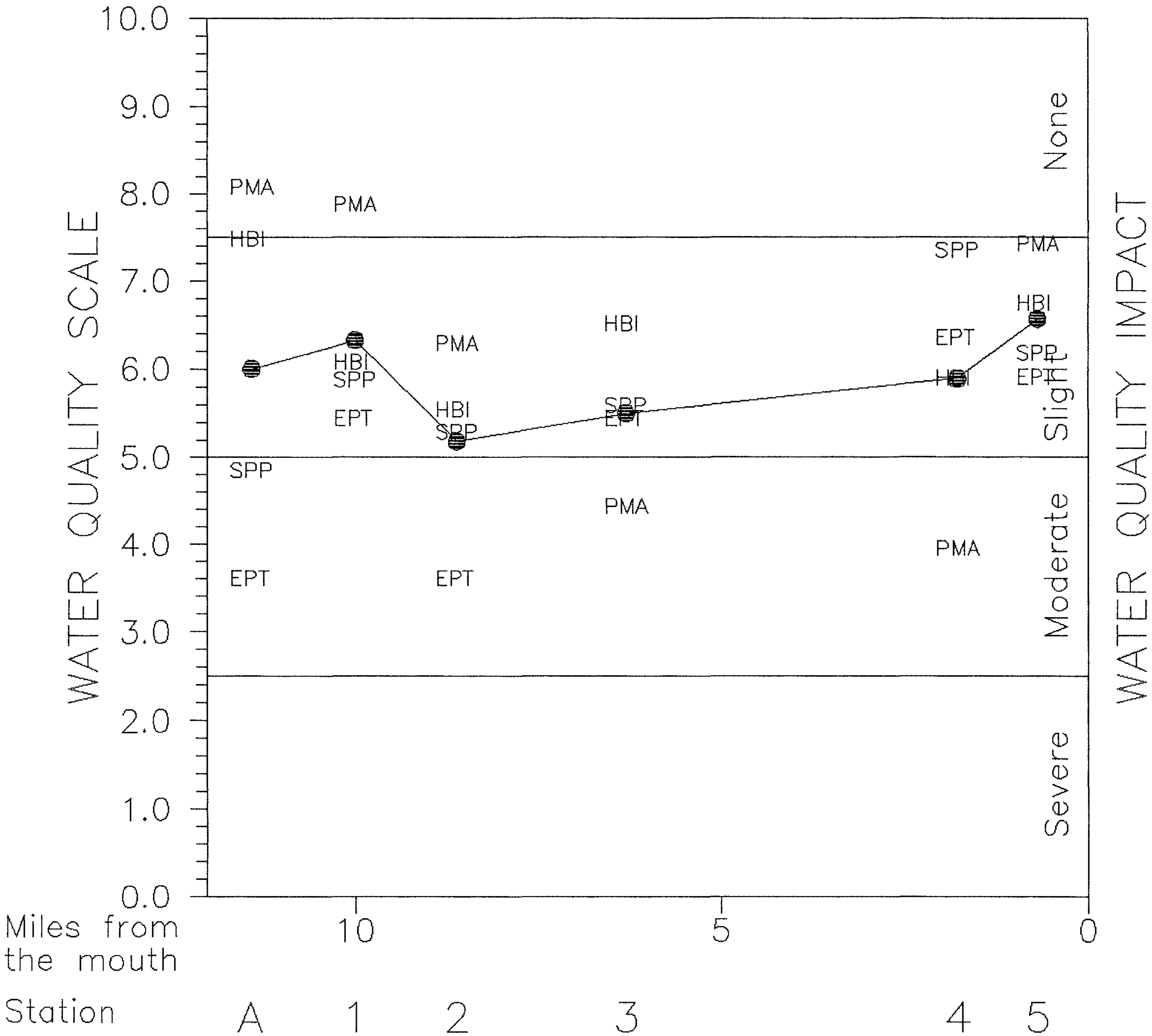


Table 1. Impact Source Determination, Canacadea Creek, 1998. Numbers represent similarity to community type models for each impact category. The highest similarities at each station are highlighted. Similarities less than 50% are less conclusive.

	STATION					
Community Type	CDEA 0A	CDEA 01	CDEA 02	CDEA 03	CDEA 04	CDEA 05
Natural: minimal human impacts	44	42	38	38	35	48
Nutrient additions; mostly nonpoint, agricultural	41	45	51	40	45	51
Toxic: industrial, municipal, or urban run-off	34	56	64	39	47	47
Organic: sewage effluent, animal wastes	24	41	46	32	42	59
Complex: municipal/industrial	19	33	39	26	41	49
Siltation	43	54	59	50	65	55
Impoundment	26	32	38	46	52	53

TABLE 2. STATION LOCATIONS FOR CANACADEA CREEK, ALLEGANY AND STEUBEN COUNTIES, NEW YORK (see map).

STATION	LOCATION
A	Alfred 200 m above treatment plant discharge 11.4 miles upstream of mouth latitude/longitude: 42°15'50": 77°46'40"
01	Alfred Station 30 m above Rt. 21 bridge 10.00 miles upstream of mouth latitude/longitude: 42°16'17"; 77°45'22"
02	below Alfred 100 m below Satterlee Hill Rd. bridge 8.6 miles upstream of mouth latitude/longitude: 42°17'23"; 77°44'53"
03	Almond 20 m above Depot St. bridge 6.3 miles upstream of mouth latitude/longitude: 42°19'10"; 77°44'09"
04	Hornell 100 m above Rt. 21 bridge 1.8 miles upstream of mouth latitude/longitude: 42°20'00"; 77°40'56"
05	Hornell 10 m above Main St. bridge 0.7 miles upstream of mouth latitude/longitude: 42°19'46"; 77°3'956"

Figure 2	Site Overview Map	Canacadea Creek

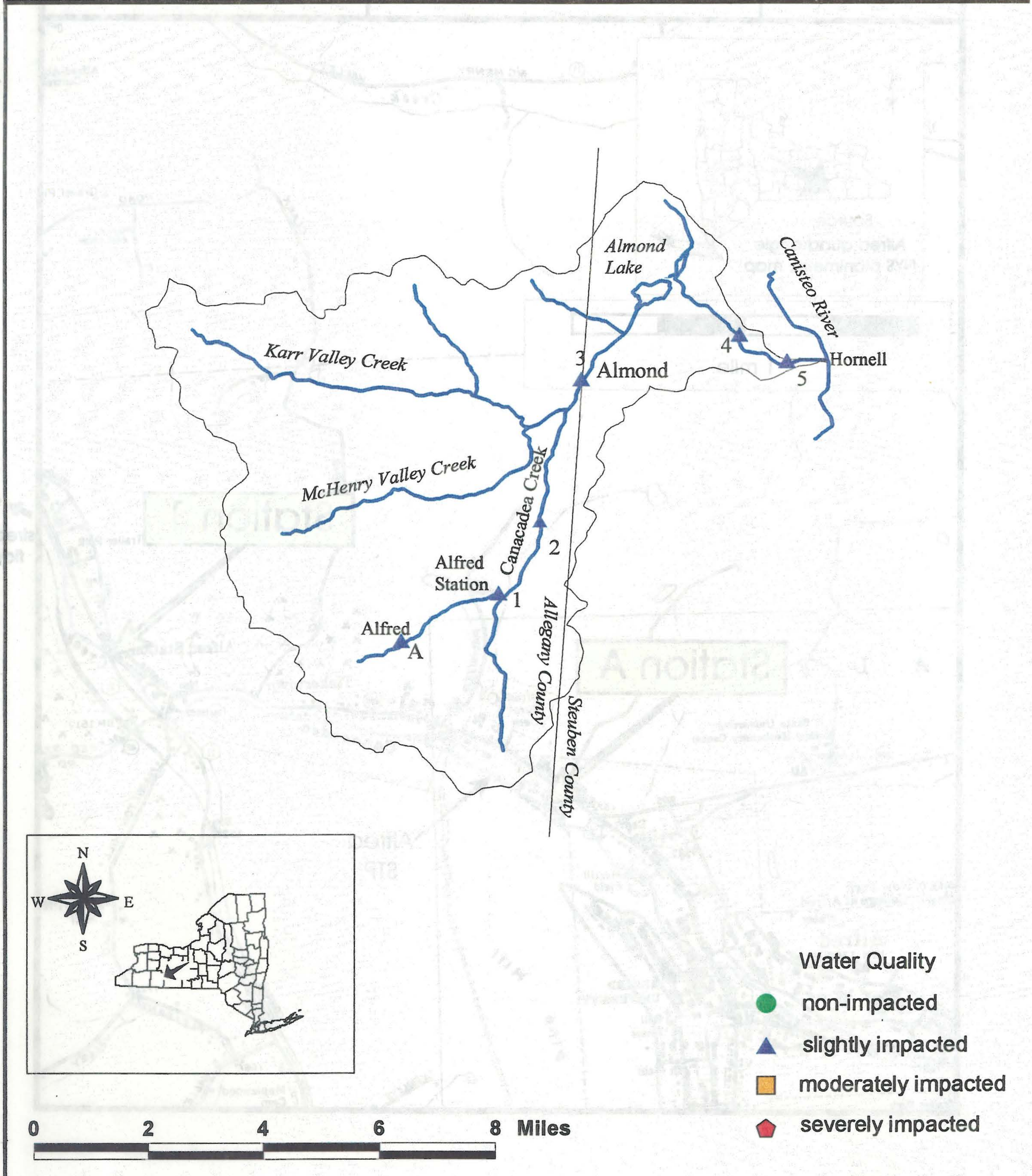


Figure 3a	Site Location Map	Canacadea Creek

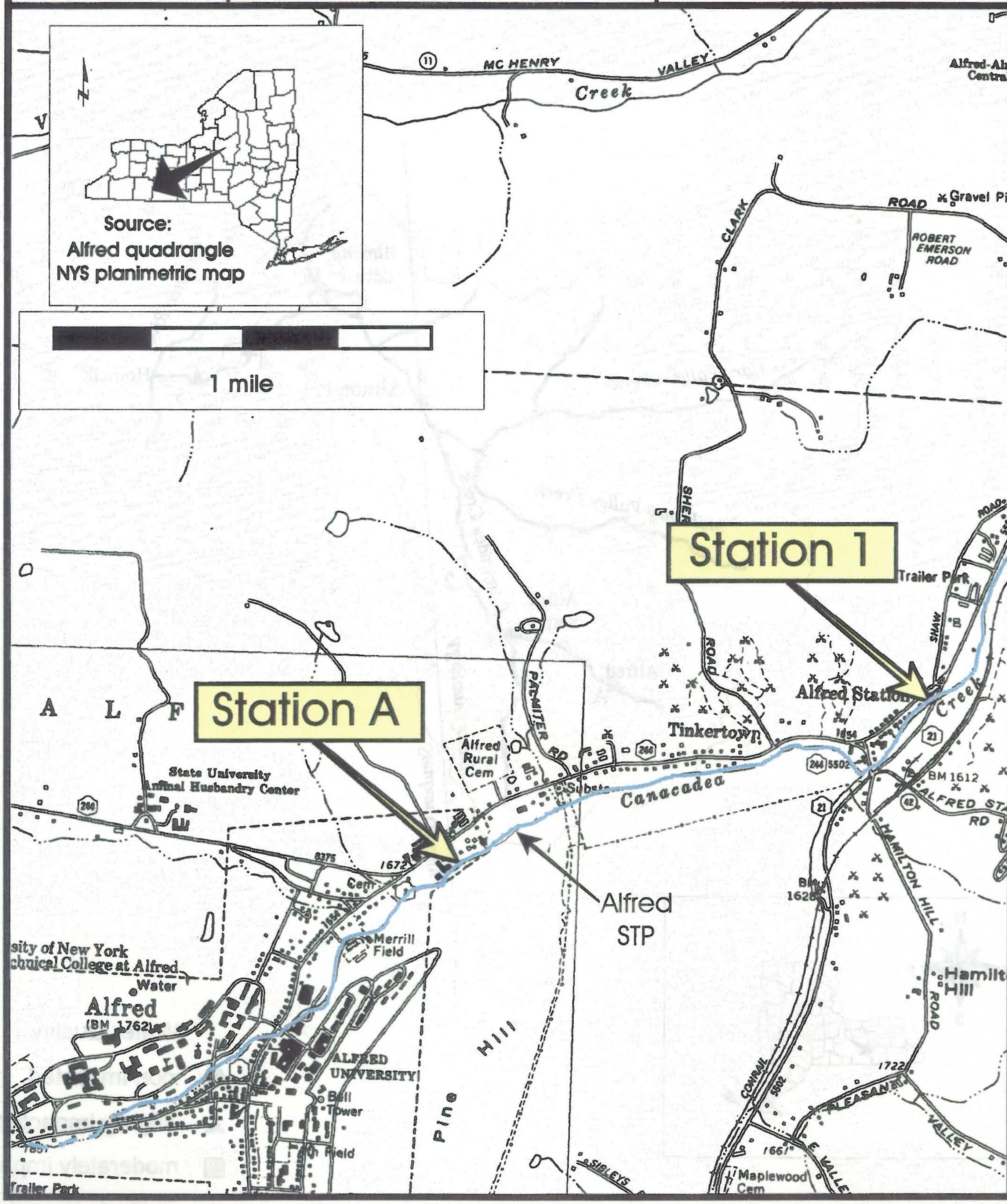
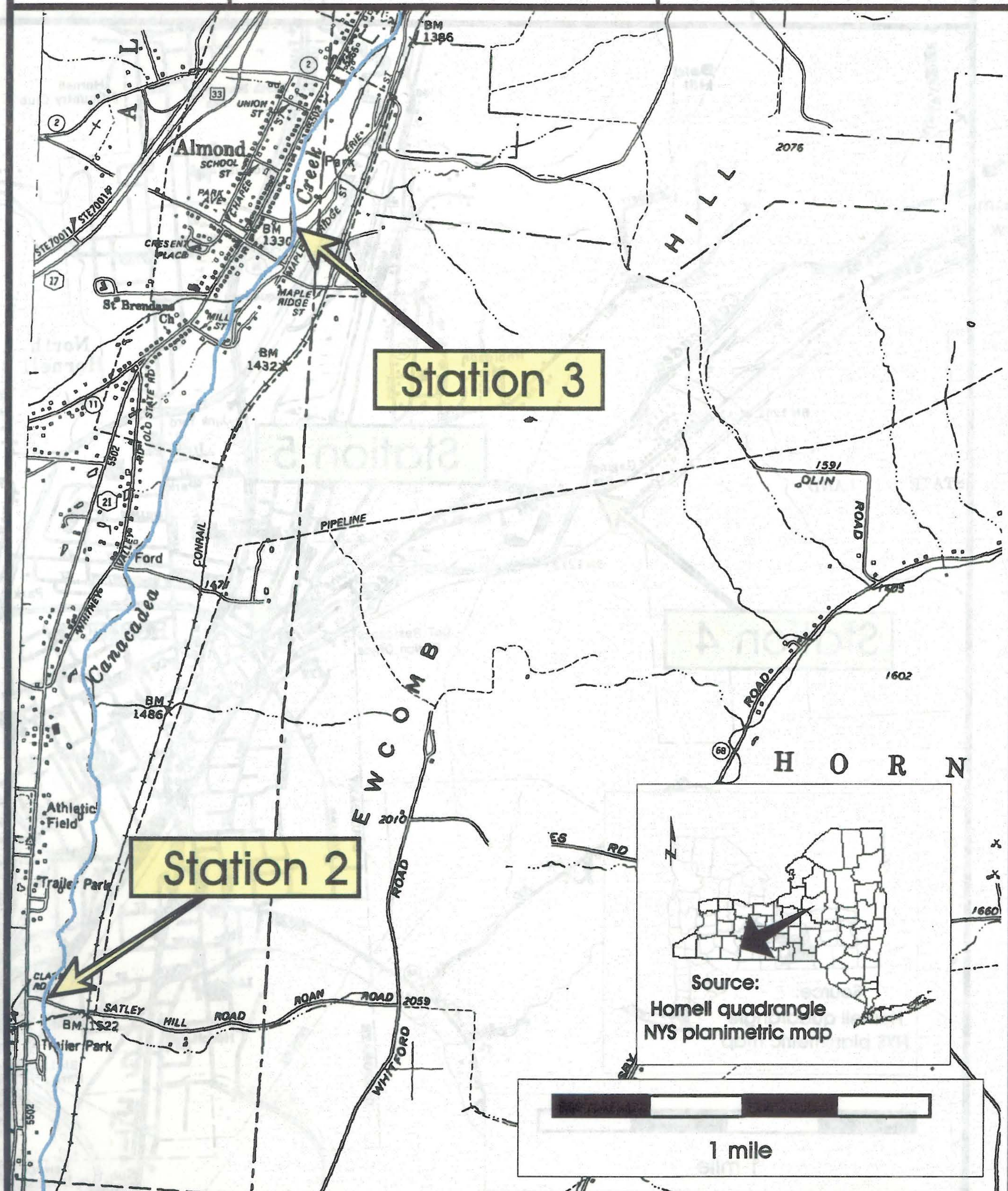


Figure 3b | **Site Location Map** | **Canacadea Creek**



stream flow

Figure 3c	Site Location Map	Canacadea Creek

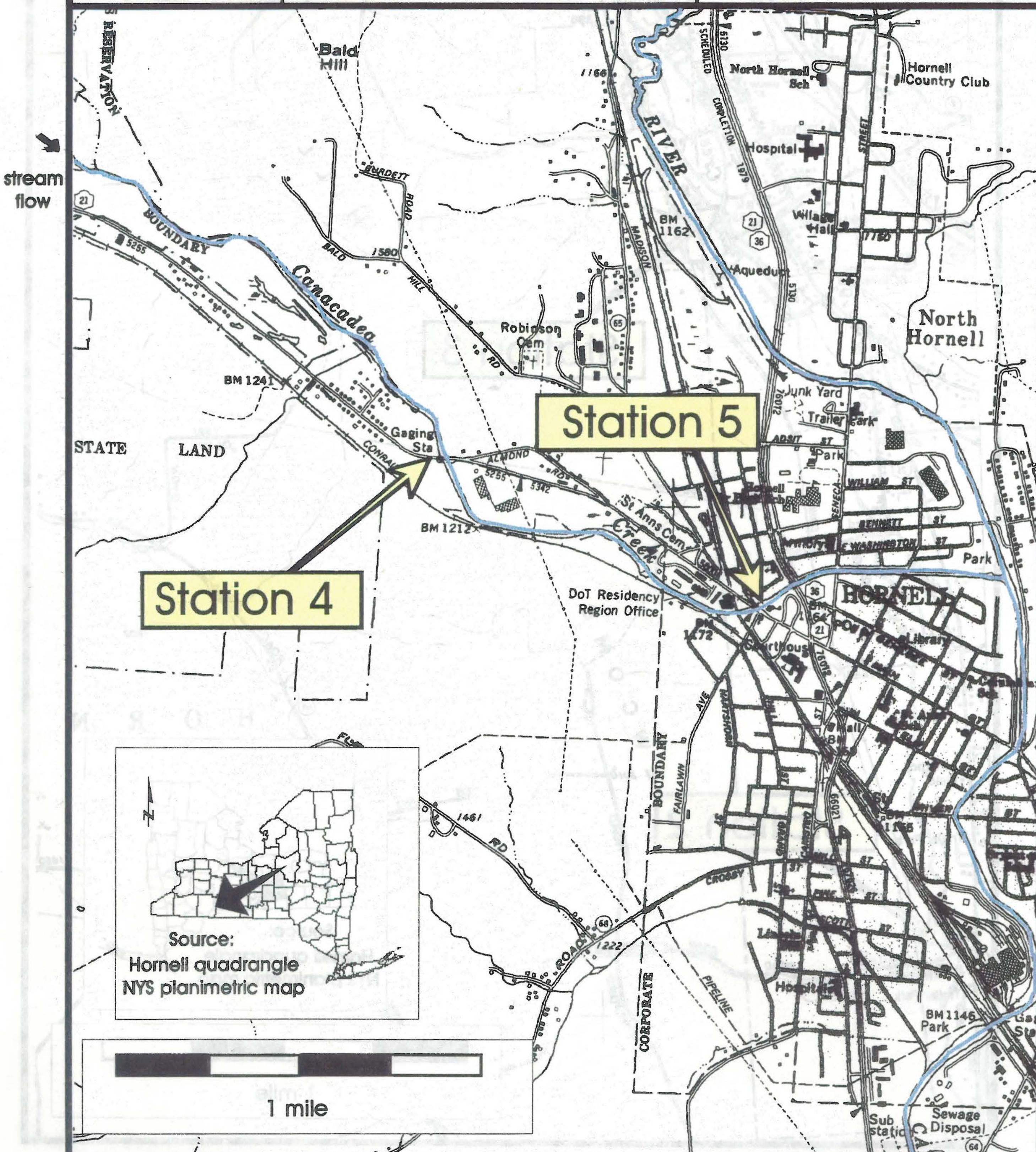


TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN CANACADEA CREEK, ALLEGANY AND STEUBEN COUNTIES, NEW YORK, AUGUST 13, 1998.

PLATYHELMINTHES
TURBELLARIA
Undetermined Turbellaria
NEMERTEA
Prostoma graecense
ANNELIDA
OLIGOCHAETA
Undetermined Lumbricina
Tubificidae
Aulodrilus piqueti
Aulodrilus sp.
Rhyacodrilus sp.
Naididae
Nais behningi
Nais bretscheri
Nais variabilis
Ophidonais serpentina
MOLLUSCA
GASTROPODA
Physidae
Physella sp.
Ancylidae
Ferrissia sp.
PELECYPODA
Sphaeriidae
Musculium sp.
ARTHROPODA
CRUSTACEA
AMPHIPODA
Gammaridae
Gammarus sp.
DECAPODA
Cambaridae
Undetermined Cambaridae
INSECTA
EPHEMEROPTERA
Baetidae
Acentrella sp.
Baetis flavistriga
Baetis sp.
Heptageniidae
Leucrocuta sp.
Stenonema vicarium
Stenonema sp.
Tricorythidae
Tricorythodes sp.
Caenidae
Caenis sp.
PLECOPTERA
Leuctridae
Leuctra sp.
COLEOPTERA
Dytiscidae
Undetermined Dytiscidae
Elmidae
Stenelmis crenata
MEGALOPTERA
Corydalidae
Nigronia serricornis
TRICHOPTERA
Philopotamidae
Dolophilodes sp.
Hydropsychidae
Cheumatopsyche sp.
Hydropsyche bronta
Hydropsyche morosa
Hydropsyche slossonae
Hydropsyche sparna
Hydropsyche sp.
Hydroptilidae
Hydroptila sp.
DIPTERA
Tipulidae
Antocha sp.
Hexatoma sp.
Simuliidae
Simulium tuberosum
Simulium venustum
Simulium vittatum
Simulium sp.
Athericidae
Atherix sp.
Empididae
Hemerodromia sp.
Muscidae
Undetermined Muscidae
Chironomidae
Tanypodinae
Thienemannimyia gr. spp.
Diamesinae
Potthastia gaedii

TABLE 3 (continued). MACROINVERTEBRATE SPECIES COLLECTED IN CANACADEA CREEK, ALLEGANY AND STEUBEN COUNTIES, NEW YORK, AUGUST 13, 1998.

Chironomidae
Orthocladiinae
Cricotopus bicinctus
Cricotopus tremulus gr.
Cricotopus triannulatus
Cricotopus trifascia gr.
Cricotopus vierriensis
Eukiefferiella brehmi gr.
Eukiefferiella devonica gr.
Orthocladius nr. dentifer
Parachaetocladius sp.
Parametriocnemus lundbecki
Rheocricotopus robacki
Thienemanniella xena?
Tvetenia bavarica gr.
Tvetenia vitracies
Chironominae
Chironomini
Microtendipes pedellus gr.
Polypedilum aviceps
Polypedilum convictum
Tanytarsini
Micropsectra sp.
Rheotanytarsus exiguus gr.
Tanytarsus glabrescens gr.
Tanytarsus guerlus gr.

STREAM SITE:	Canacadea Creek Station A
LOCATION:	Alfred, New York, upstream of WWTF
DATE:	August 13, 1998
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

PLATYHELMINTHES			
TURBELLARIA		Undetermined Turbellaria	1
ANNELIDA			
OLIGOCHAETA		Undetermined Lumbricina	1
	Naididae	Nais variabilis	5
		Ophidonais serpentina	3
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis flavistriga	31
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	3
	Hydropsychidae	Hydropsyche slossonae	1
DIPTERA	Tipulidae	Hexatoma sp.	1
	Simuliidae	Simulium sp.	3
	Empididae	Hemerodromia sp.	5
	Chironomidae	Thienemannimyia gr. spp.	1
		Cricotopus vierriensis	3
		Parachaetocladius sp.	1
		Parametriocnemus lundbecki	1
		Rheocricotopus robacki	1
		Thienemanniella xena?	1
		Tvetenia bavarica gr.	1
		Polypedilum aviceps	37

SPECIES RICHNESS	18 (fair)
BIOTIC INDEX	4.52 (good)
EPT RICHNESS	3 (fair)
MODEL AFFINITY	70 (excellent)
ASSESSMENT	slightly impacted

DESCRIPTION This site was located in Alfred, off Route 244, upstream of the discharge of the WWTF. The substrate was composed primarily of gravel, with some rubble and sand, and was considered to be a less-than-ideal habitat for invertebrate life. Topographic maps indicate the stream is intermittent approximately one mile upstream of this site, and the headwater situation may also have influenced the fauna. The fauna was composed mostly of midges and mayflies; no stoneflies were found. Overall water quality was assessed as slightly impacted.

STREAM SITE:	Canacadea Creek Station 1
LOCATION:	Alfred Station, New York, above Route 21 bridge, below WWTF
DATE:	August 13, 1998
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA	Naididae	Nais variabilis	13
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis flavistriga	27
PLECOPTERA	Leuctridae	Leuctra sp.	1
COLEOPTERA	Dytiscidae	Undetermined Dytiscidae	1
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	1
	Hydropsychidae	Hydropsyche bronta	1
		Hydropsyche morosa	1
	Hydroptilidae	Hydroptila sp.	1
DIPTERA	Tipulidae	Hexatoma sp.	1
	Simuliidae	Simulium tuberosum	1
	Empididae	Hemerodromia sp.	2
	Muscidae	Undetermined Muscidae	13
	Chironomidae	Thienemannimyia gr. spp.	3
		Cricotopus bicinctus	4
		Cricotopus tremulus gr.	2
		Cricotopus trifascia gr.	14
		Orthocladius nr. dentifer	1
		Parametriocnemus lundbecki	1
		Rheocricotopus robacki	1
		Polypedilum aviceps	10
		Micropsectra sp.	1

SPECIES RICHNESS	21 (good)
BIOTIC INDEX	5.64 (good)
EPT RICHNESS	6 (good)
MODEL AFFINITY	68 (excellent)
ASSESSMENT	slightly impacted

DESCRIPTION The site was located in Alfred Station, downstream of the discharge of the WWTF. Gravel and sand dominated the substrate, as at Station A upstream. The fauna was altered somewhat from Station A, with reductions in the cleanwater midge Polypedilum aviceps. Indices were comparable to Station A, however, and water quality was similarly assessed as slightly impacted.

STREAM SITE:	Canacadea Creek Station 2
LOCATION:	below Alfred, New York, Satterlee Hill Road bridge
DATE:	August 13, 1998
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA	Naididae	Nais bretscheri	1
		Nais variabilis	18
MOLLUSCA			
GASTROPODA	Physidae	Physella sp.	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	1
		Baetis flavistriga	17
TRICHOPTERA	Hydropsychidae	Hydropsyche bronta	4
DIPTERA	Tipulidae	Hexatoma sp.	1
	Simuliidae	Simulium venustum	3
		Simulium vittatum	4
	Empididae	Hemerodromia sp.	2
	Muscidae	Undetermined Muscidae	3
	Chironomidae	Thienemannimyia gr. spp.	5
		Cricotopus bicinctus	3
		Cricotopus trifascia gr.	17
		Eukiefferiella brehmi gr.	1
		Orthocladius nr. dentifer	2
		Parametriocnemus lundbecki	2
		Polypedilum aviceps	14
		Micropsectra sp.	1

SPECIES RICHNESS	19 (good)
BIOTIC INDEX	6.07 (good)
EPT RICHNESS	3 (fair)
MODEL AFFINITY	57 (good)
ASSESSMENT	slightly impacted

DESCRIPTION The kick sample was taken below the Satterlee Hill Road bridge, downstream of Alfred Station. Filmentous algae and periphyton were abundant on the rocks. The tolerant worm Nais variabilis increased from the downstream site. Water quality indices were somewhat poorer than at Station 1, but water quality remained within the category of slight impact.

STREAM SITE:	Canacadea Creek Station 3
LOCATION:	Almond, New York, above Depot Street bridge
DATE:	August 13, 1998
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDAE			
OLIGOCHAETA	Naididae	Nais variabilis	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis sp.	5
	Heptageniidae	Stenonema sp.	1
	Tricorythidae	Tricorythodes sp.	3
COLEOPTERA	Dytiscidae	Undetermined Dytiscidae	3
TRICHOPTERA	Hydropsychidae	Hydropsyche bronta	3
		Hydropsyche morosa	1
		Hydropsyche slossonae	3
DIPTERA	Simuliidae	Simulium vittatum	1
	Empididae	Hemerodromia sp.	1
	Muscidae	Undetermined Muscidae	4
	Chironomidae	Thienemannimyia gr. spp.	15
		Cricotopus bicinctus	2
		Cricotopus trifascia gr.	22
		Eukiefferiella devonica gr.	1
		Orthocladius nr. dentifer	2
		Microtendipes pedellus gr.	1
		Polypedilum aviceps	29
		Rheotanytarsus exiguus gr.	1
		Tanytarsus glabrescens gr.	1

SPECIES RICHNESS	20 (good)
BIOTIC INDEX	5.29 (good)
EPT RICHNESS	6 (good)
MODEL AFFINITY	46 (fair)
ASSESSMENT	slightly impacted

DESCRIPTION The sampling site was above the Depot Street bridge in Almond. Midges dominated the invertebrate fauna, with poor representation by mayflies and caddisflies. Indices remained within the range of slightly impacted water quality.

STREAM SITE:	Canacadea Creek Station 4
LOCATION:	Hornell, New Hyork, above Route 21 bridge
DATE:	August 13, 1998
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

PLATYHELMINTHES			
TURBELLARIA		Undetermined Turbellaria	1
ANNELIDA			
OLIGOCHAETA	Tubificidae	Aulodrilus sp.	1
		Rhyacodrilus sp.	1
	Naididae	Nais behningi	1
ARTHROPODA			
CRUSTACEA			
DECAPODA	Cambaridae	Undetermined Cambaridae	1
EPHEMEROPTERA	Baetidae	Baetis flavistriga	2
	Heptageniidae	Stenonema sp.	2
	Caenidae	Caenis sp.	1
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	9
		Hydropsyche bronta	12
		Hydropsyche morosa	2
		Hydropsyche sparna	2
		Hydropsyche sp.	1
DIPTERA	Tipulidae	Antocha sp.	1
	Empididae	Hemerodromia sp.	2
	Chironomidae	Thienemannimyia gr. spp.	2
		Potthastia gaedii	1
		Cricotopus bicinctus	7
		Cricotopus trifascia gr.	31
		Parametriocnemus lundbecki	2
		Tvetenia vitracies	2
		Microtendipes pedellus gr.	7
		Polypedilum aviceps	1
		Polypedilum convictum	5
		Rheotanytarsus exiguus gr.	2
		Tanytarsus guerlus gr.	1

SPECIES RICHNESS	26 (good)
BIOTIC INDEX	5.78 (good)
EPT RICHNESS	8 (good)
MODEL AFFINITY	43 (fair)
ASSESSMENT	slightly impacted

DESCRIPTION The sampling site was at the Route 21 bridge, downstream of Almond Lake and upstream of Hornell. The Almond Lake outlet was approximately 1.5 miles upstream, and the water appeared turbid. The invertebrate fauna was dominated by midges and caddisflies. Water quality was assessed as slightly impacted.

STREAM SITE: Canacadea Creek Station 5
LOCATION: Hornell, New York, above Main Street bridge
DATE: August 13, 1998
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

ANNELIDA			
OLIGOCHAETA	Tubificidae	Aulodrilus piqueti	1
		Undet. Tubificidae w/o cap. setae	1
MOLLUSCA			
GASTROPODA	Ancylidae	Ferrissia sp.	3
PELECYPODA	Sphaeriidae	Musculium sp.	1
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	Gammarus sp.	1
DECAPODA	Cambaridae	Undetermined Cambaridae 7	
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis sp.	1
	Heptageniidae	Leucrocuta sp.	1
		Stenacron interpunctatum	10
		Stenonema vicarium	9
	Caenidae	Caenis sp.	2
COLEOPTERA	Elmidae	Stenelmis crenata	9
MEGALOPTERA	Corydalidae	Nigronia serricornis	1
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	33
		Hydropsyche bronta	2
DIPTERA	Athericidae	Atherix sp.	7
	Empididae	Hemerodromia sp.	1
	Chironomidae	Thienemannimyia gr. spp.	4
		Tvetenia vitracies	3
		Polypedilum convictum	1
		Micropsectra sp.	1
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS 22 (good)
BIOTIC INDEX 5.10 (good)
EPT RICHNESS 7 (good)
MODEL AFFINITY 64 (good)
ASSESSMENT slightly impacted

DESCRIPTION The kick sample was taken above the Route 21 bridge in Hornell. The substrate was mostly gravel, and the water was very turbid. Crayfish were very numerous at this site. Invertebrate indices were within the range of slightly impacted water quality, as at upstream sites.

LABORATORY DATA SUMMARY

STREAM NAME: Canacadea Creek
DRAINAGE: 05 (Chemung)
DATE SAMPLED: 08/13/1998
COUNTY: Allegany, Steuben
SAMPLING METHOD: Traveling kick

STATION LOCATION	A above STP	01 Alfred Station	02 below Alfred Sta.	03 Almond
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Polypedilum aviceps 37 % intolerant midge	Baetis flavistriga 27 % intolerant mayfly	Nais variabilis 18 % tolerant worm	Polypedilum aviceps 29 % intolerant midge
Intolerant = not tolerant of poor water quality; Facultative = occurring over a wide range of water quality; Tolerant = tolerant of poor water quality. 2.	Baetis flavistriga 31 % intolerant mayfly	Cricotopus trifascia gr. 14 % facultative midge	Cricotopus trifascia gr. 17 % facultative midge	Cricotopus trifascia gr. 22 % facultative midge
3.	Hemerodromia sp. 5 % facultative fly	Undetermined Muscidae 13 % facultative fly	Baetis flavistriga 17 % intolerant mayfly	Thienemannimyia gr. spp. 15 % facultative midge
4.	Nais variabilis 5 % tolerant worm	Nais variabilis 13 % tolerant worm	Polypedilum aviceps 14 % intolerant midge	Baetis sp. 5 % facultative mayfly
5.	Ophidonais serpentina 3 % facultative worm	Polypedilum aviceps 10 % intolerant midge	Thienemannimyia gr. spp. 5 % facultative midge	Undetermined Muscidae 4 % facultative fly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	46 (8)	37 (9)	45 (8)	74 (9)
Trichoptera (caddisflies)	4 (2)	4 (4)	4 (1)	7 (3)
Ephemeroptera (mayflies)	31 (1)	27 (1)	18 (2)	9 (3)
Plecoptera (stoneflies)	0 (0)	1 (1)	0 (0)	0 (0)
Coleoptera (beetles)	0 (0)	1 (1)	0 (0)	3 (1)
Oligochaeta (worms)	9 (3)	13 (1)	19 (2)	1 (1)
Other (**)	10 (4)	17 (4)	14 (6)	6 (3)
TOTAL	100 (18)	100 (21)	100 (19)	100 (20)
SPECIES RICHNESS	18	21	19	20
HBI INDEX	4.52	5.64	6.07	5.29
EPT RICHNESS	3	6	3	6
PERCENT MODEL AFFINITY	70	68	57	46
FIELD ASSESSMENT	slight impact	slight impact	moderate impact	moderate impact
OVERALL ASSESSMENT	slight impact	slight impact	slight impact	slight impact

LABORATORY DATA SUMMARY

STREAM NAME: Canacadea Creek
DATE SAMPLED: 08/13/1998
SAMPLING METHOD: Traveling kick
DRAINAGE: 05 (Chemung)
COUNTY: Allegany, Steuben

STATION LOCATION	04 Hornell, Rt. 21	05 Hornell, Main St.		
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Cricotopus trifascia gr. 31 % facultative midge	Cheumatopsyche sp. 33 % facultative caddisfly		
Intolerant = not tolerant of poor water quality; Facultative = occurring over a wide range of water quality; Tolerant = tolerant of poor water quality. 2.	Hydropsyche bronta 12 % facultative caddisfly	Stenacron interpunctatum 10 % facultative mayfly		
3.	Cheumatopsyche sp. 9 % facultative caddisfly	Stenelmis crenata 9 % facultative riffle beetle		
4.	Microtendipes pedellus gr. 7 % facultative midge	Stenonema vicarium 9 % intolerant mayfly		
5.	Cricotopus bicinctus 7 % facultative midge	Atherix sp. 7 % intolerant fly		
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF				
Chironomidae (midges)	61 (11)	10 (5)		
Trichoptera (caddisflies)	26 (5)	35 (2)		
Ephemeroptera (mayflies)	5 (3)	23 (5)		
Plecoptera (stoneflies)	0 (0)	0 (0)		
Coleoptera (beetles)	0 (0)	9 (1)		
Oligochaeta (worms)	3 (3)	2 (2)		
Other (**)	5 (4)	21 (7)		
TOTAL	100 (26)	100 (22)		
SPECIES RICHNESS	26	22		
HBI INDEX	5.78	5.10		
EPT RICHNESS	8	7		
PERCENT MODEL AFFINITY	43	64		
FIELD ASSESSMENT	moderate impact	moderate impact		
OVERALL ASSESSMENT	slight impact	slight impact		

FIELD DATA SUMMARY

STREAM NAME: Canacadea Creek

REACH: Alfred to Hornell — **DATE SAMPLED: 08/13/1998**

FIELD PERSONNEL INVOLVED: Abele, Gabriel

STATION	A	01	02	03
ARRIVAL TIME AT STATION	**9:50**	**8:45**	**9:15**	**11:00**
LOCATION	**Alfred - above STP**	**Alfred Station**	**below Alfred - Satterlee Hill Rd.**	**Almond - Depot St. br.**
PHYSICAL CHARACTERISTICS				
Width (meters)	2	4	3	30
Depth (meters)	0.1	0.2	0.1	0.1
Current speed (cm per sec.)	40	75	-	-
Substrate (%)				
rock (> 10 in., or bedrock)	10	10		10
rubble (2.5 - 10 in.)	20	20	40	30
gravel (0.08 - 2.5 in.)	40	30	30	30
sand (0.06 - 2.0 mm)	20	20	20	20
silt (0.004 - 0.06 mm)	10	20	10	10
clay (< 0.004 mm)				
Embeddedness (%)	50	40	30	40
CHEMICAL MEASUREMENTS				
temperature (° C)	15.6	12.4	13.9	18.2
specific conductance (μmhos)	572	563	545	541
D.O. (mg per l)	8.9	9.0	10.3	9.5
pH	8.5	8.2	8.6	8.6
BIOLOGICAL ATTRIBUTES				
canopy (%)	90	40	30	20
Aquatic Vegetation				
algae - suspended in water column				
algae - attached, filamentous			present	present
algae - diatoms	present	present	present	present
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)				
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)		X	X	X
Megaloptera (dobsonflies, alderflies)				
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	X	X	X	X
Simuliidae (black flies)	X	X		
Decapoda (crayfish)	X			
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)		X		
Other	X	X	X	
FIELD ASSESSMENT	slt	slt	mod	mod

FIELD DATA SUMMARY				
STREAM NAME: Canacadea Creek **REACH: Alfred to Hornell** **DATE SAMPLED: 08/13/1998** **FIELD PERSONNEL INVOLVED: Abele, Gabriel**				
STATION	**04**	**05**		
ARRIVAL TIME AT STATION	**11:30**	**12:15**		
LOCATION	**Hornell - Rt. 21 bridge**	**Hornell - Main St. bridge**		
PHYSICAL CHARACTERISTICS				
Width (meters)	15	20		
Depth (meters)	0.2	0.2		
Current speed (cm per sec.)	80	60		
Substrate (%)				
rock (> 10 in., or bedrock)	10			
rubble (2.5 - 10 in.)	30	10		
gravel (0.08 - 2.5 in.)	30	40		
sand (0.06 - 2.0 mm)	10	20		
silt (0.004 - 0.06 mm)	20	30		
clay (< 0.004 mm)				
Embeddedness (%)	40	50		
CHEMICAL MEASUREMENTS				
temperature (° C)	22.6	23.3		
specific conductance (μmhos)	240	364		
D.O. (mg per l)	8.6	9.3		
pH	8.5	8.7		
BIOLOGICAL ATTRIBUTES				
canopy (%)	40	0		
Aquatic Vegetation				
algae - suspended in water column				
algae - attached, filamentous				
algae - diatoms	present	present		
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X		
Plecoptera (stoneflies)				
Trichoptera (caddisflies)	X	X		
Coleoptera (beetles)	X	X		
Megaloptera (dobsonflies, alderflies)		X		
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	X	X		
Simuliidae (black flies)				
Decapoda (crayfish)		X		
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other	X	X		
FIELD ASSESSMENT	mod	mod		

Appendix I. BIOLOGICAL METHODS FOR KICK SAMPLING

A. Rationale. The use of the standardized kick sampling method provides a biological assessment technique that lends itself to rapid assessments of stream water quality.

B. Site Selection. Sampling sites are selected based on these criteria: (1) The sampling location should be a riffle with a substrate of rubble, gravel, and sand. Depth should be one meter or less, and current speed should be at least 0.4 meters per second. (2) The site should have comparable current speed, substrate type, embeddedness, and canopy cover to both upstream and downstream sites to the degree possible. (3) Sites are chosen to have a safe and convenient access.

C. Sampling. Macroinvertebrates are sampled using the standardized traveling kick method. An aquatic net is positioned in the water at arms' length downstream and the stream bottom is disturbed by foot, so that the dislodged organisms are carried into the net. Sampling is continued for a specified time and for a specified distance in the stream. Rapid assessment sampling specifies sampling 5 minutes for a distance of 5 meters. The net contents are emptied into a pan of stream water. The contents are then examined, and the major groups of organisms are recorded, usually on the ordinal level (e.g., stoneflies, mayflies, caddisflies). Larger rocks, sticks, and plants may be removed from the sample if organisms are first removed from them. The contents of the pan are poured into a U.S. No. 30 sieve and transferred to a quart jar. The sample is then preserved by adding 95% ethyl alcohol to which rose bengal stain has been added.

D. Sample Sorting and Subsampling. In the laboratory the sample is rinsed with tap water in a U.S. No. 40 standard sieve to remove any fine particles left in the residues from field sieving. The sample is transferred to an enamel pan and distributed homogeneously over the bottom of the pan. A small amount of the sample is randomly removed with a spatula and placed in a petri dish with alcohol. This portion is examined under a dissecting stereomicroscope and 100 organisms are removed from the debris. As they are removed, they are sorted into major groups, placed in vials containing 70 percent alcohol, and counted. Following identification of a subsample, if the results are ambiguous, suspected of being spurious, or do not yield a clear water quality assessment, additional subsampling may be required.

E. Organism Identification. All organisms are identified to the species level whenever possible. Chironomids and oligochaetes are slide-mounted and viewed through a compound microscope; most other organisms are identified as whole specimens using a dissecting stereomicroscope. The number of individuals in each species, and the total number of individuals in the sample is recorded on a data sheet. All organisms from the subsample are archived, either slide-mounted or preserved in alcohol.

Appendix II. MACROINVERTEBRATE COMMUNITY PARAMETERS

1. Species richness. This is the total number of species or taxa found in the sample. Expected ranges for 100-specimen subsamples of kick samples in most streams in New York State are: greater than 26, non-impacted; 19-26, slightly impacted; 11-18, moderately impacted; less than 11, severely impacted.

2. EPT value. EPT denotes the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in an average 100-organism subsample. These are considered to be mostly clean-water organisms, and their presence generally is correlated with good water quality (Lenat, 1987). Expected ranges from most streams in New York State are: greater than 10, non-impacted; 6-10, slightly impacted; 2-5, moderately impacted; and 0-1, severely impacted.

3. Biotic index. The Hilsenhoff Biotic Index is a measure of the tolerance of the organisms in the sample to organic pollution (sewage effluent, animal wastes) and low dissolved oxygen levels. It is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals. On a 0-10 scale, tolerance values range from intolerant (0) to tolerant (10). For purposes of characterizing species' tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. Values are listed in Hilsenhoff (1987); additional values are assigned by the NYS Stream Biomonitoring Unit. The most recent values for each species are listed in the Quality Assurance document (Bode et al., 1996). Ranges for the levels of impact are: 0-4.50, non-impacted; 4.51-6.50, slightly impacted; 6.51-8.50, moderately impacted; and 8.51-10.00, severely impacted.

4. Percent Model Affinity is a measure of similarity to a model non-impacted community based on percent abundance in 7 major groups (Novak and Bode, 1992). Percentage similarity is used to measure similarity to a community of 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta, and 10% Other. Ranges for the levels of impact are: >64, non-impacted; 50-64, slightly impacted; 35-49, moderately impacted; and <35, severely impacted.

Bode, R.W., M.A. Novak, and L.E. Abele. 1996. Quality assurance work plan for biological stream monitoring in New York State. NYS DEC technical report, 89 pp.

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. The Great Lakes Entomologist 20(1): 31-39.

Lenat, D. R. 1987. Water quality assessment using a new qualitative collection method for freshwater benthic macroinvertebrates. North Carolina DEM Tech. Report. 12 pp.

Novak, M.A., and R.W. Bode. 1992. Percent model affinity: a new measure of macroinvertebrate community composition. J. N. Am. Benthol. Soc. 11(1):80-85.

Appendix III. LEVELS OF WATER QUALITY IMPACT IN STREAMS.

The description of overall stream water quality based on biological parameters uses a four-tiered system of classification. Level of impact is assessed for each individual parameter, and then combined for all parameters to form a consensus determination. Four parameters are used: species richness, EPT value, biotic index, and percent model affinity. The consensus is based on the determination of the majority of the parameters; since parameters measure different aspects of the community, they cannot be expected to always form unanimous assessments. The ranges given for each parameter are based on 100-organism subsamples of macroinvertebrate riffle kick samples, and also apply to most multiplate samples, with the exception of percent model affinity.

1. Non-impacted

Indices reflect excellent water quality. The macroinvertebrate community is diverse, usually with at least 27 species in riffle habitats. Mayflies, stoneflies, and caddisflies are well-represented; the EPT value is greater than 10. The biotic index value is 4.50 or less. Percent model affinity is greater than 64. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges which minimally alter the biota.

2. Slightly impacted

Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness usually is 19-26. Mayflies and stoneflies may be restricted, with EPT values of 6-10. The biotic index value is 4.51-6.50. Percent model affinity is 50-64. Water quality is usually not limiting to fish survival, but may be limiting to fish propagation.

3. Moderately impacted

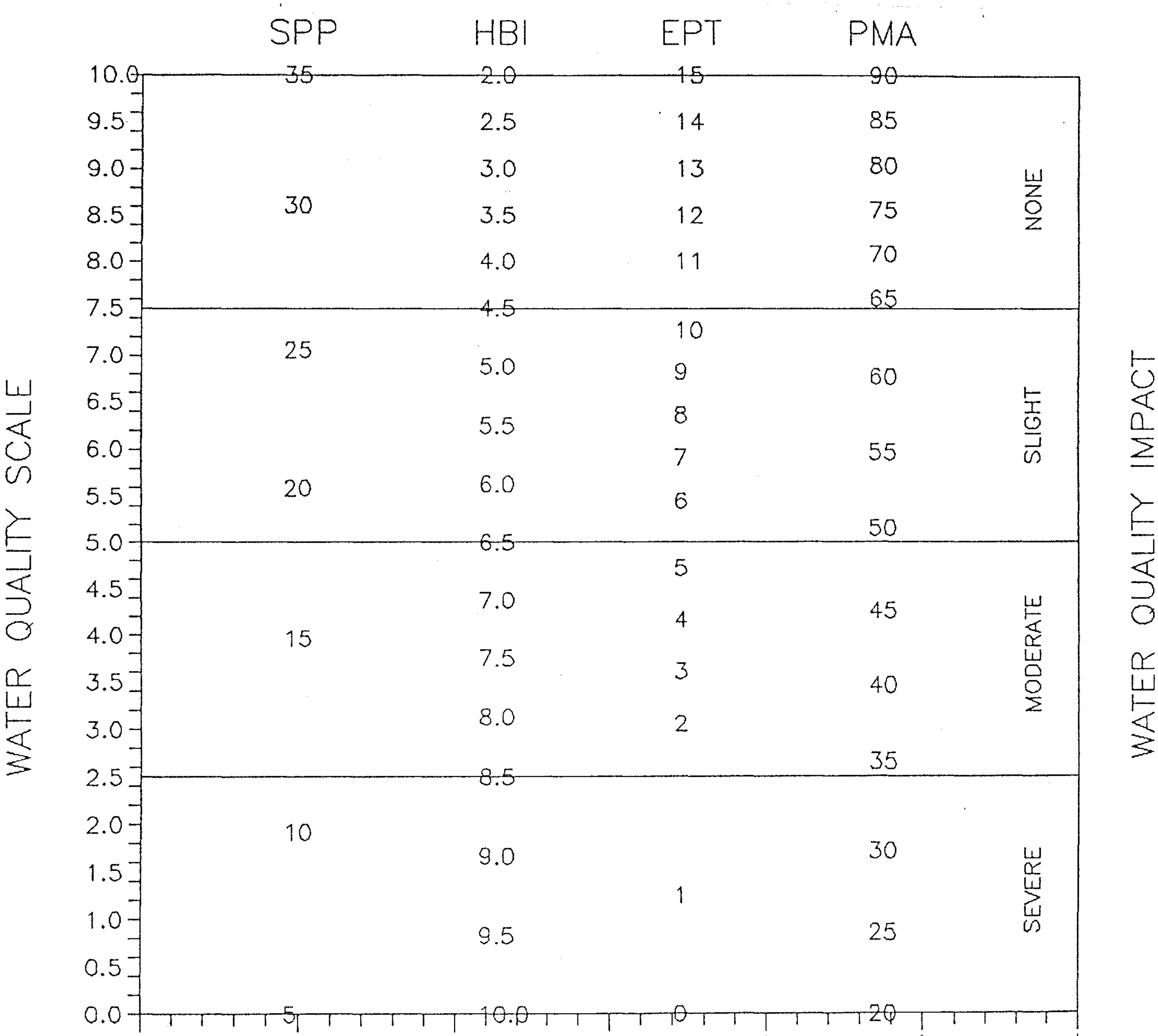
Indices reflect fair water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT value is 2-5. The biotic index value is 6.51-8.50. The percent model affinity value is 35-49. Water quality often is limiting to fish propagation, but usually not to fish survival.

4. Severely impacted

Indices reflect poor water quality. The macroinvertebrate community is limited to a few tolerant species. Species richness is 10 or less. Mayflies, stoneflies, and caddisflies are rare or absent; EPT value is 0-1. The biotic index value is greater than 8.50. Percent model affinity is less than 35. The dominant species are almost all tolerant, and are usually midges and worms. Often 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

Appendix IV. BIOLOGICAL ASSESSMENT PROFILE OF INDEX VALUES

The Biological Assessment Profile of index values, developed by Mr. Phil O'Brien, Division of Water, NYS DEC, is a method of plotting biological index values on a common scale of water quality impact. Values from the four indices defined in Appendix II are converted to a common 0-10 scale as shown in the figure below.



To plot survey data, each site is positioned on the x-axis according to river miles from the mouth, and the scaled values for the four indices are plotted on the common scale. The mean scale value of the four indices is represented by a circle; this value is used for graphing trends between sites, and represents the assessed impact for each site.

Appendix V

WATER QUALITY ASSESSMENT CRITERIA

for non-navigable flowing waters

	Species Richness	Hilsenhoff Biotic Index	EPT Value	Percent Model Affinity#	Diversity*
Non-Impacted	>26	0.00-4.50	>10	>64	>4
Slightly Impacted	19-26	4.51-6.50	6-10	50-64	3.01-4.00
Moderately Impacted	11-18	6.51-8.50	2-5	35-49	2.01-3.00
Severely Impacted	0-10	8.51-10.00	0-1	<35	0.00-2.00

Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.

* Diversity criteria are used for multiplate samples but not for traveling kick samples.

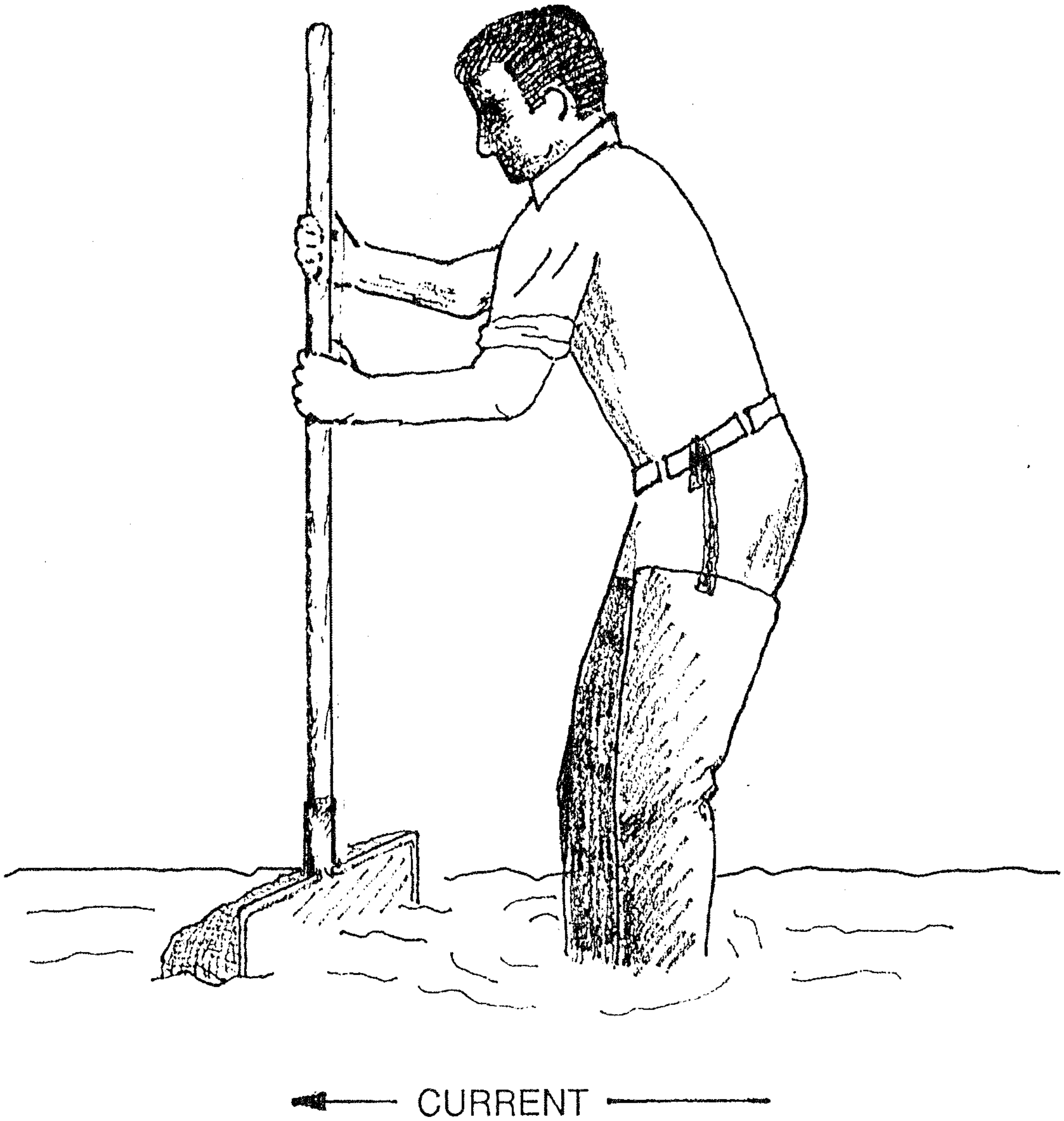
WATER QUALITY ASSESSMENT CRITERIA

for navigable flowing waters

	Species Richness	Hilsenhoff Biotic Index	EPT Value	Diversity
Non-Impacted	>21	0.00-7.00	>5	>3.00
Slightly Impacted	17-21	7.01-8.00	4-5	2.51-3.00
Moderately Impacted	12-16	8.01-9.00	2-3	2.01-2.50
Severely Impacted	0-11	9.01-10.00	0-1	0.00-2.00

Appendix VI.

THE TRAVELING KICK SAMPLE



Rocks and sediment in the stream riffle are dislodged by foot upstream of a net; dislodged organisms are carried by the current in the net. Sampling is continued for a specified time, gradually moving downstream to cover a specified distance.

AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

Mayfly nymphs are often the most numerous organisms found in clean streams. They are sensitive to most types of pollution, including low dissolved oxygen (less than 5 ppm), chlorine, ammonia, metals, pesticides, and acidity. Most mayflies are found clinging to the undersides of rocks.

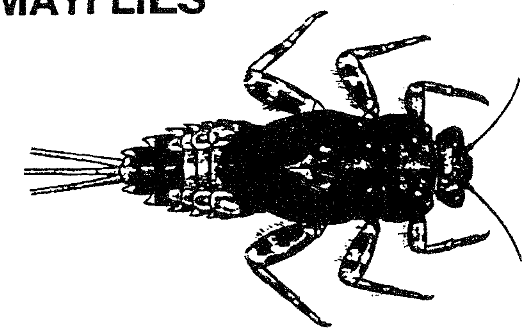
Stonefly nymphs are mostly limited to cool, well-oxygenated streams. They are sensitive to most of the same pollutants as mayflies except acidity. They are usually much less numerous than mayflies. The presence of even a few stoneflies in a stream suggests that good water quality has been maintained for several months.

Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in recovery zones below sewage discharges.

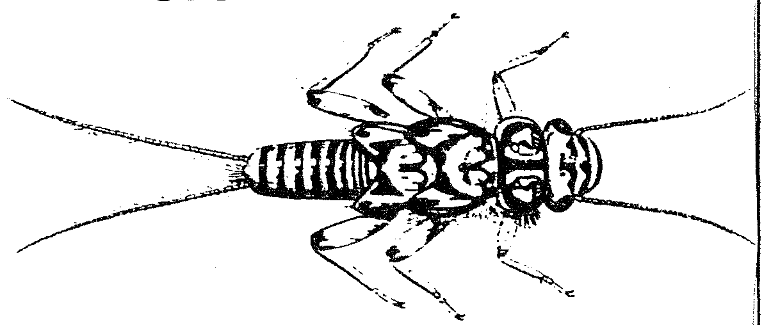
The most common beetles in streams are riffle beetles and water pennies. Most of these require a swift current and an adequate supply of oxygen, and are generally considered clean-water indicators.

Illustrations by Arwin Provonsha
In McCafferty: Aquatic Entomology

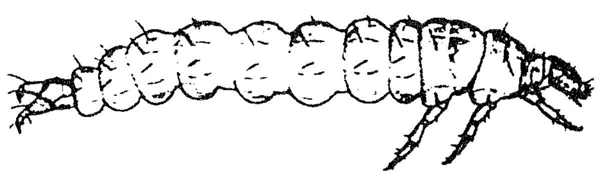
MAYFLIES



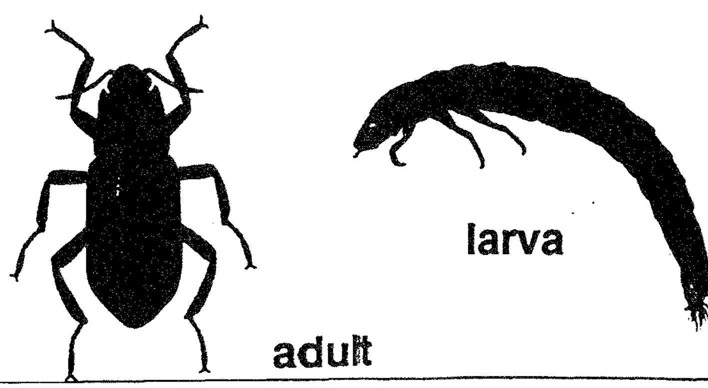
STONEFLIES



CADDISFLIES



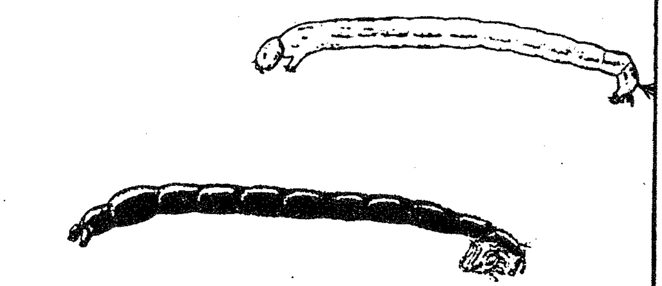
BEETLES



AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE POOR WATER QUALITY

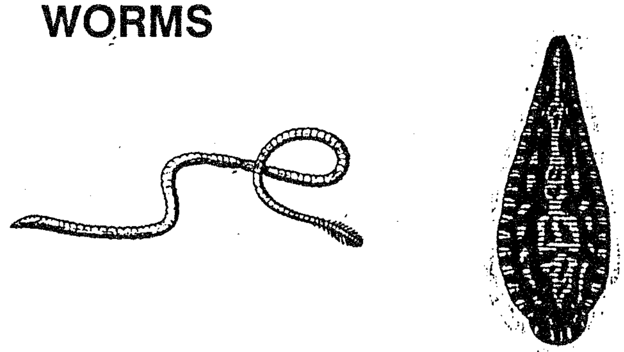
MIDGES

Midges are the most common aquatic flies. The larvae occur in almost any aquatic situation. Many species are very tolerant to pollution; most of these are red and are called "bloodworms". Other species filter suspended food particles, and are numerous in sewage recovery zones.



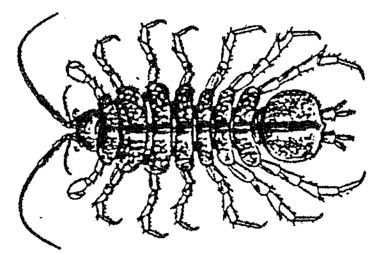
WORMS

The segmented worms include the leeches and the small aquatic earthworms. The latter are more common, though usually unnoticed. They burrow in the substrate and feed on bacteria in the sediment. They can thrive under conditions of severe pollution and very low oxygen levels, and are thus valuable pollution indicators. Many leeches are also tolerant of poor water quality.



SOWBUGS

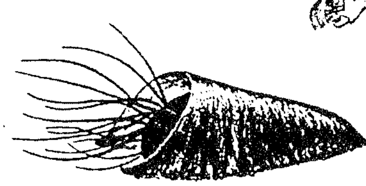
Aquatic sowbugs are crustaceans that are often numerous in situations of high organic content and low oxygen levels. When numerous they can indicate a stream segment in the recovery stage of sewage pollution.



BLACK FLIES

Black fly larvae have specialized structures for filtering plankton and bacteria from the water, and require a strong current. Some species are numerous in the decomposition and recovery zones of sewage pollution, while others are intolerant of pollutants.

larva



pupa

Illustrations by Arwin Provonsha
In McCafferty: Aquatic Entomology

APPENDIX VIII. THE RATIONALE OF BIOLOGICAL MONITORING

Biological monitoring as applied here refers to the use of resident benthic macroinvertebrate communities as indicators of water quality. Macroinvertebrates are larger-than-microscopic invertebrate animals that inhabit aquatic habitats; freshwater forms are primarily aquatic insects, worms, clams, snails, and crustaceans.

Concept

Nearly all streams are inhabited by a community of benthic macroinvertebrates. The species comprising the community each occupy a distinct niche defined and limited by a set of environmental requirements. The composition of the macroinvertebrate community is thus determined by many factors, including habitat, food source, flow regime, temperature, and water quality. The community is presumed to be controlled primarily by water quality if the other factors are determined to be constant or optimal. Community components which can change with water quality include species richness, diversity, balance, abundance, and presence/absence of tolerant or intolerant species. Various indices or metrics are used to measure these community changes. Assessments of water quality are based on metric values of the community, compared to expected metric values.

Advantages

The primary advantages to using macroinvertebrates as water quality indicators are:

1) they are sensitive to environmental impacts
2) they are less mobile than fish, and thus cannot avoid discharges
3) they can indicate effects of spills, intermittent discharges, and lapses in treatment
4) they are indicators of overall, integrated water quality, including synergistic effects and substances lower than detectable limits
5) they are abundant in most streams and are relatively easy and inexpensive to sample
6) they are able to detect non-chemical impacts to the habitat, such as siltation or thermal changes
7) they are vital components of the aquatic ecosystem and important as a food source for fish
8) they are more readily perceived by the public as tangible indicators of water quality
9) they can often provide an on-site estimate of water quality
10) they can often be used to identify specific stresses or sources of impairment
11) they can be preserved and archived for decades, allowing for direct comparison of specimens
12) they bioaccumulate many contaminants, so that analysis of their tissues is a good monitor of toxic substances in the aquatic food chain

Limitations

Biological monitoring is not intended to replace chemical sampling, toxicity testing, or fish surveys. Each of these measurements provides information not contained in the others. Similarly, assessments based on biological sampling should not be taken as being representative of chemical sampling. Some substances may be present in levels exceeding ambient water quality criteria, yet have no apparent adverse community impact.

APPENDIX IX. GLOSSARY

assessment: a diagnosis or evaluation of water quality

benthos: organisms occurring on or in the bottom substrate of a waterbody

biomonitoring: the use of biological indicators to measure water quality

community: a group of populations of organisms interacting in a habitat

drainage basin: an area in which all water drains to a particular waterbody; watershed

EPT value: the number of species of mayflies, stoneflies, and caddisflies in a sample

facultative: occurring over a wide range of water quality; neither tolerant nor intolerant of poor water quality

fauna: the animal life of a particular habitat

impact: a change in the physical, chemical, or biological condition of a waterbody

impairment: a detrimental effect caused by an impact

index: a number, metric, or parameter derived from sample data used as a measure of water quality

intolerant: unable to survive poor water quality

macroinvertebrate: a larger-than-microscopic invertebrate animal that lives at least part of its life in aquatic habitats

multiplate: multiple-plate sampler, a type of artificial substrate sampler of aquatic macroinvertebrates

organism: a living individual

rapid bioassessment: a biological diagnosis of water quality using field and laboratory analysis designed to allow assessment of water quality in a short turn-around time; usually involves kick sampling and laboratory subsampling of the sample

riffle: wadeable stretch of stream usually with a rubble bottom and sufficient current to have the water surface broken by the flow; rapids

species richness: the number of macroinvertebrate species in a sample or subsample

station: a sampling site on a waterbody

survey: a set of samplings conducted in succession along a stretch of stream

tolerant: able to survive poor water quality

APPENDIX X. CHARACTERISTICS OF HEADWATER STREAM SITES

Headwater stream sites are defined as first-order or second-order stream locations close to the stream source, usually less than three miles. The natural characteristics of headwaters may sometimes result in an erroneous assessment of impacted water quality.

1) Headwater sites have reduced upstream recruitment resource populations to provide colonization by drift, and may have reduced species richness.

2) Headwater sites usually are nutrient-poor, lower in food resources, and less productive.

3) The reduced, simplified fauna of headwater sites may result in a community in which a few intolerant species may be very abundant. For 100-organism subsamples, this can affect many community indices: species richness, EPT richness, and percent model affinity. The dominant species averages 37% of the total fauna, and is an intolerant mayfly (e.g., Epeorus, Paraleptophlebia, Stenonema), stonefly (e.g., Leuctridae or Capniidae), caddisfly (e.g., Brachycentrus, Dolophilodes, or Chimarra), or riffle beetle (e.g., Optioservus or Promoresia).

4) Although headwater stream invertebrate communities are dominated by intolerant species, many community indices are low. Average index values are: species richness - 19, EPT richness - 8, Hilsenhoff biotic index - 3.05, and percent model affinity - 57. These indices are based on headwaters of a number of streams across New York State.

5) Recommended corrective action for non-representative indices from headwater sites: a correction factor of 1.5 may be applied to species richness, EPT richness, and percent model affinity. Criteria for the use of the correction factor are: the headwater location is as described above, the community is dominated by intolerant species, and the above indices (species richness, EPT richness, and percent model affinity) are judged to be non-representative of actual water quality. Alternatively, index values may be maintained, and the overall assessment may be adjusted up to non-impacted if the above criteria are met.

APPENDIX XI. METHODS FOR IMPACT SOURCE DETERMINATION

Definition Impact Source Determination (ISD) is the procedure for identifying types of impacts that exert deleterious effects on a waterbody. While the analysis of benthic macroinvertebrate communities has been shown to be an effective means of determining severity of water quality impacts, it has been less effective in determining what kind of pollution is causing the impact. Impact Source Determination uses community types or models to ascertain the primary factor influencing the fauna.

Development of methods The method found to be most useful in differentiating impacts in New York State streams was the use of community types, based on composition mostly by family and genus. It may be seen as an elaboration of Percent Model Affinity (Novak and Bode, 1992), which is based on class and order. A large database of macroinvertebrate data was required to develop ISD methods. The database included several sites known or presumed to be impacted by specific impact types. The impact types were mostly known by chemical data or land use. These sites were grouped into the following general categories: nonpoint nutrient additions, toxics, sewage effluent or animal wastes, municipal/industrial, siltation, impoundment, and natural. Cluster analysis was then performed within each group, using percent similarity, mostly at the family or genus level. Within each group different clusters were identified, each cluster usually composed of 4-5 sites with high biological similarity. From each cluster a hypothetical model was then formed to represent a model cluster community type; sites within the cluster had at least 50 percent similarity to this model. These community type models formed the basis for Impact Source Determination (see tables following). The method was tested by calculating percent similarity to all the models, and determining which model was the most similar to the test site. Some models were initially adjusted to achieve maximum representation of the impact type. New models are developed when similar communities are recognized from several streams.

Use of the ISD methods Impact Source Determination is based on similarity to existing models of community types (see tables following). The model that exhibits the highest similarity to the test data denotes the likely impact source type, or may indicate "natural", lacking an impact. In the graphic representation of ISD, the highest similarity of each source type is identified, and similarities that are within 5% of the highest. Similarities less than 50% are considered less conclusive. The determination of impact source type is used in conjunction with assessment of severity of water quality impact to provide an overall assessment of water quality.

Limitations These methods were developed for data derived from 100-organism subsamples of traveling kick samples from riffles of New York State streams. Application of the methods for data derived from other sampling methods, habitats, or geographical areas would likely require modification of the models.

NATURAL

	A	B	C	D	E	F	G	H	I	J	K	L	M
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	-	5	-	5	-	5	5	-	-	-	5	5
HIRUDINEA	-	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMMARIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
Isonychia	5	5	-	5	20	-	-	-	-	-	-	-	-
BAETIDAE	20	10	10	10	10	5	10	10	10	10	5	15	40
HEPTAGENIIDAE	5	10	5	20	10	5	5	5	5	10	10	5	5
LEPTOPHLEBIIDAE	5	5	-	-	-	-	-	-	5	-	-	25	5
EPHEMERELLIDAE	5	5	5	10	-	10	10	30	-	5	-	10	5
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	5	5	-	5	5	15	5	5	5	5
Psephenus	5	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus	5	-	20	5	5	-	5	5	5	5	-	-	-
Promoresia	5	-	-	-	-	-	25	-	-	-	-	-	-
Stenelmis	10	5	10	10	5	-	-	-	10	-	-	-	5
PHILOPOTAMIDAE	5	20	5	5	5	5	5	-	5	5	5	5	5
HYDROPSYCHIDAE	10	5	15	15	10	10	5	5	10	15	5	5	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	5	5	-	-	-	20	-	5	5	5	5	5	-
SIMULIIDAE	-	-	-	5	5	-	-	-	-	5	-	-	-
Simulium vittatum	-	-	-	-	-	-	-	-	-	-	-	-	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	5	-	-	-	-
CHIRONOMIDAE													
Tanypodinae	-	5	-	-	-	-	-	-	5	-	-	-	-
Diamesinae	-	-	-	-	-	-	5	-	-	-	-	-	-
Cardiocladius	-	5	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	5	5	-	-	10	-	-	5	-	-	5	5	5
Eukiefferiella/ Tvetenia	5	5	10	-	-	5	5	5	-	5	-	5	5
Parametriocnemus	-	-	-	-	-	-	-	5	-	-	-	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	20	-	-	10	20	20	5	-
Polypedilum (all others)	5	5	5	5	5	-	5	5	-	-	-	-	-
Tanytarsini	-	5	10	5	5	20	10	10	10	10	40	5	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100

	NONPOINT NUTRIENTS, PESTICIDES									TOXIC					
	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
OLIGOCHAETA	-	-	-	5	-	-	-	-	-	-	10	20	5	5	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-	5	-	-	-	5
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	10	10	-	20	10	5
GAMMARIDAE	-	-	-	5	-	-	-	-	-	5	-	-	-	5	5
Isonychia	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-
BAETIDAE	5	15	20	5	20	10	10	5	10	15	10	20	-	-	5
HEPTAGENIIDAE	-	-	-	-	5	5	5	5	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-
Caenis/Tricorythodes	-	-	-	-	5	-	-	5	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenus	5	-	-	5	-	5	5	-	-	-	-	-	-	-	-
Optioservus	10	-	-	5	-	-	15	5	-	-	-	-	-	-	-
Promoresia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	15	-	10	15	5	25	5	10	10	15	-	40	35	5
PHILOPOTAMIDAE	15	5	10	5	-	25	5	-	-	10	-	-	-	-	-
HYDROPSYCHIDAE	15	15	15	25	10	35	20	45	20	20	10	15	10	35	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	5	-	15	5	5	-	-	-	40	-	-	-	-	-	-
Simulium vittatum	-	-	-	-	-	-	-	-	5	-	20	-	-	-	5
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE															
Tanypodinae	-	-	-	-	-	-	5	-	-	5	10	-	-	-	25
Cardiocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	10	15	10	5	-	-	-	-	5	15	10	25	10	5	10
Eukiefferiella/ Tvetenia	-	15	10	5	-	-	-	-	5	-	-	20	10	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	10	20	10	5	10	5	10	-	-	-	-	5
Tanytarsini	10	10	10	5	20	5	5	10	-	-	-	-	-	-	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

SEWAGE EFFLUENT, ANIMAL WASTES

	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	5	35	15	10	10	35	40	10	20	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	10	-	-	-	-	-	-
ASELLIDAE	5	10	-	10	10	10	10	50	-	5
GAMMARIDAE	-	-	-	-	-	10	-	10	-	-
Isonychia	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	10	5	-	-	-	-	5	-
HEPTAGENIIDAE	10	10	10	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	5	-
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	-	10	10	-	-	-	-	-	-
PHILOPOTAMIDAE	-	-	-	-	-	-	-	-	-	-
HYDROPSYCHIDAE	45	-	10	10	10	-	-	10	5	-
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	25	10	35	-	-	5	5
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE										
Tanypodinae	-	5	-	-	-	-	-	-	5	5
Cardiocladius	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	-	10	15	-	-	10	10	-	5	5
Eukiefferiella/ Tvetenia	-	-	10	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	10	-	-	60
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	10	60	-	30	10	5	5
Tanytarsini	10	10	10	10	-	-	-	10	40	-
TOTAL	100	100	100	100	100	100	100	100	100	100

MUNICIPAL/INDUSTRIAL

	A	B	C	D	E	F	G
PLATYHELMINTHES	-	40	-	-	-	5	-
OLIGOCHAETA	20	20	70	10	-	20	-
HIRUDINEA	-	5	-	-	-	-	-
GASTROPODA	-	-	-	-	-	5	-
SPHAERIIDAE	-	5	-	-	-	-	-
ASELLIDAE	10	5	10	10	15	5	-
GAMMARIDAE	40	-	-	-	15	-	5
Isonychia	-	-	-	-	-	-	-
BAETIDAE	5	-	-	-	5	-	10
HEPTAGENIIDAE	5	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-
Caenis/Tricorythodes	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-
Promoresia	-	-	-	-	-	-	-
Stenelmis	5	-	-	10	5	-	5
PHILOPOTAMIDAE	-	-	-	-	-	-	-
HYDROPSYCHIDAE	10	-	-	50	20	-	40
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	-	-	-	20
EMPIDIDAE	-	5	-	-	-	-	-
CHIRONOMIDAE							
Tanypodinae	-	10	-	-	5	15	-
Cardiocladius	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	5	10	20	-	5	10	5
Eukiefferiella/ Tvetenia	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	-	-
Polypedilum (all others)	-	-	-	10	20	40	10
Tanytarsini	-	-	-	10	10	-	5
TOTAL	100	100	100	100	100	100	100

	SILTATION					IMPOUNDMENT									
	A	B	C	D	E	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	10	-	10	-	5	-	50	10	-
OLIGOCHAETA	5	-	20	10	5	5	-	40	5	10	5	10	5	5	-
HIRUDINEA	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	10	-	5	5	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-	-	-	5	25	-
ASELLIDAE	-	-	-	-	-	-	5	5	-	10	5	5	5	-	-
GAMMARIDAE	-	-	-	10	-	-	-	10	-	10	50	-	5	10	-
<u>Isonychia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	20	5	-	-	5	-	5	-	-	5	-	-	5
HEPTAGENIIDAE	5	10	-	20	5	5	5	-	5	5	5	5	-	5	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Caenis/Tricorythodes</u>	5	20	10	5	15	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Psephenus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
<u>Optioservus</u>	5	10	-	-	-	-	-	-	-	-	-	-	-	5	-
<u>Promoresia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Stenelmis</u>	5	10	10	5	20	5	5	10	10	-	5	35	-	5	10
PHILOPOTAMIDAE	-	-	-	-	-	5	-	-	5	-	-	-	-	-	30
HYDROPSYCHIDAE	25	10	-	20	30	50	15	10	10	10	10	20	5	15	20
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
SIMULIIDAE	5	10	-	-	5	5	-	5	-	35	10	5	-	-	15
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE															
Tanypodinae	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus/ Orthocladius</u>	25	-	10	5	5	5	25	5	-	10	-	5	10	-	-
<u>Eukiefferiella/ Tvetenia</u>	-	-	10	-	5	5	15	-	-	-	-	-	-	-	-
<u>Parametriocnemus</u>	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
<u>Chironomus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum aviceps</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum</u> (all others)	10	10	10	5	5	5	-	-	20	-	-	5	5	5	5
Tanytarsini	10	10	10	10	5	5	10	5	30	-	-	5	10	10	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100